

Bear Lake
Fisheries Assessment, 2014-2015
Barron County, WI
(MWBIC: 2105100)



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Executive Summary

Bear Lake was surveyed during 2014-2015 to assess the abundance and population demographics (i.e., size and age structure, growth, and recruitment) of sport fish, and make comparisons with previous surveys. Creel surveys were conducted during the open water fishing and ice fishing seasons to determine angler effort, preference, and harvest for all fish species throughout the entire year. The adult walleye population estimate was 911 or 0.7 fish/acre (95% C.I. = 512-1,310), which was similar to the most recent survey in 2008 when the population estimate was 661 or 0.5 fish/acre (95% C.I. 434-888). The walleye population had high size structure and the sex ratio was skewed to females. Large fingerling (6-8 in) walleye should continue to be stocked at a rate of 20 fish/acre on an alternate year basis, with the goal of creating a moderate density walleye fishery of 1.5-2 adults/acre. Northern pike was the dominant gamefish species in Bear Lake, and the population is best described as having high density and low size structure. The density of northern pike has appeared to increase based on the CPE from netting and their reduced growth rates. Other angling regulations should be considered to improve the size structure of northern pike. Increasing the harvest of smaller (<24") northern pike and preserving the size structure of large northern pike has the potential to increase the overall size structure of the population and potentially improve walleye stocking success. The largemouth population was characterized as having moderate density, low size structure and poor growth rates. Anglers are encouraged to continue to harvest largemouth bass, especially those less than 14 in. If the number of small (<14 in) largemouth bass can be reduced, the size structure and growth rates of the largemouth bass population should improve. This was the first creel survey for Bear Lake since the no minimum length limit for largemouth bass was implemented and anglers harvested more largemouth bass than previously documented; however, it appeared that anglers tended to harvest the largest bass. Panfish played an important role in the Bear Lake fishery, as the majority of the angling effort on was directed at panfish species, mainly bluegill and crappie. Size structure and growth of bluegill was average and the abundance of crappie was above average for Bear Lake.

Introduction

Bear Lake is a 1,358 acre drainage lake located on the Barron-Washburn County line, near the Village of Haugen, Wisconsin (Figure 1). The lake has a maximum depth of 87 feet and there is 14.9 miles of shoreline. Much of the shoreline is developed, but there is a considerable amount of undeveloped shoreline that is owned by Barron County and a Boy Scout camp. Boyer Creek is the main tributary stream and is located on the west end of Bear Lake. The outlet of Kekegama Lake also enters Bear Lake from the north. There is an outlet at the southeast portion of Bear Lake that forms the headwaters of Bear Creek. This outlet is controlled by a dam that is maintained by Barron County. The dam raises the lake level by 13 feet.

Bear Lake has a diverse fish community that is comprised of walleye *Sander vitreus*, northern pike *Esox lucius*, largemouth bass *Micropterus salmoides*, smallmouth bass *Micropterus dolomieu*, bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus*, pumpkinseed *Lepomis gibbosus*, green sunfish *Lepomis cyanellus*, yellow perch *Perca flavescens*, rock bass *Ambloplites rupestris*, cisco *Coregonus artedii*, white sucker *Catostomus commersoni*, bowfin *Amia calva*, and bullheads *Ameiurus spp.*

There has been an extensive history of fish stocking in Bear Lake, with walleye the most stocked species (Table 1). Although walleye are not native to Bear Lake (Becker 1983), they were first stocked in 1933. Bear Lake is a stocking dependent walleye lake. There has been a low level of natural reproduction documented (Cornelius 1998), but not enough to sustain the population. Walleye stocking efforts historically consisted of fry and small fingerling (<3 in) stockings, but since 2006 have shifted to large fingerling (6-8 in) stockings.

Anglers have access to the lake by four public boat landings (Figure 1). The base regulation for walleye in Bear Lake is an 18-in minimum length limit (MLL) with a 3-fish daily bag limit and the bass regulation is a no minimum length limit and five fish daily bag limit. Both the walleye and the bass regulations were implemented in spring 2011. All other species regulations follow the Wisconsin statewide fishing regulations.

Bear Lake is on a 6 year rotation for comprehensive surveys. Previous Wisconsin DNR fish surveys, which included walleye population estimates, were conducted in 1985, 1996, 2000, 2008, and 2014. Historic fall electrofishing surveys from 1988-2014 were

used to assess walleye stocking efficacy. During the most recent comprehensive survey report in 2008-2009, the fishery was characterized as a low density walleye population (P.E.= 0.5 adult fish/acre), an increasing largemouth bass population, a northern pike population that provided a considerable portion of the gamefish fishery, and bluegill and black crappie populations that provided a majority of the recreational angling effort and harvest (Benike 2010). Management recommendations called for implementation of the 18-in MLL and 3 fish daily bag limit for walleye, focus walleye stocking on large fingerlings, change the bass regulation to a no minimum length limit and five fish daily bag limit in an attempt to reduce bass abundance.

The objectives of this survey were to assess the status of the walleye population as part of the treaty assessment sampling rotation of lakes for the Ceded Territory of Wisconsin and assess the abundance and population demographics (i.e., size and age structure, growth, and recruitment) of other sport fish in Bear Lake and make comparisons with previous surveys.

Methods

Field Sampling:

The sport fishery in Bear Lake was sampled in 2014 with early spring fyke netting, early spring and late spring electrofishing, and fall electrofishing (Table 2).

Population abundance of adult walleye was estimated using mark and recapture methodology during the early spring netting and early spring electrofishing surveys. Walleye were considered adult fish if they were ≥ 15 in or otherwise sexable (i.e., extrusion of eggs or milt; Cichosz 2015). Abundance of adult walleye was estimated using Chapman's modification of the Petersen single-census method (Ricker 1975):

$$N = \frac{(M + 1)(C + 1)}{(R + 1)} - 1$$

where N = population estimate; M = the number of fish marked in the first (marking) sample; C = the total number of fish (marked and unmarked) captured in the second (recapture) sample; and R is the number of marked fish captured in the second sample.

Walleye were captured with fyke nets set at ice out. Fyke nets were set April 29, 2014 and checked every 24-h for 5 days. Fyke nets had 4 x 6 ft. frames, 0.5 to 0.75-in bar measure mesh, and lead lengths of 75 or 100 ft. All walleye collected in fyke nets were measured to the nearest 0.5-in TL and sexed; walleye were marked by clipping the left pelvic fin. Aging structures were collected from five walleye of each sex per 0.5-in length group. Scales were taken from walleye <12 in and dorsal spines were taken from fish ≥ 12.0 in. For the recapture period, walleye were collected by boat AC electrofishing along the entire shoreline of the lake with two dip netters at night. All walleye were measured, sexed, and checked for marks.

Largemouth bass and panfish were assessed by boat AC electrofishing at night along the shoreline during June 9-10, 2014 with two dip-netters. There were four 1.5-mile gamefish transects in which only gamefish were collected, and four 0.5-mile index transects in which all species were collected. Weights and scale samples were collected from five fish per 0.5-in length group for age and growth analysis.

The year-class strength of age-0 walleye was assessed with fall boat AC electrofishing at night with two dip-netters. The entire shoreline was sampled and all walleye, largemouth bass, and northern pike were netted. Scale samples were collected from walleye <12 in. The catch per effort (CPE) of age-0 walleye and age-1 walleye was determined by catch per mile and compared to previous fall evaluations.

Population Demographics:

Scale samples were pressed on acetate slides and age was assessed on a microfiche reader by a single interpreter. Dorsal spines were mounted in plastic, cut with a Dremel saw and age interpreted on a microfiche reader by a single interpreter. Mean length-at-age comparisons were made with previous surveys, the Barron and Polk County averages, and the regional (18 county WDNR Northern Region) averages obtained from the WDNR Fisheries and Habitat database.

The von Bertalanffy (1938) growth model was determined using mean length at age data to assess growth for walleye, largemouth bass, and northern pike using the following equation:

$$L_t = L_{inf}(1 - e^{-k(t-t_0)})$$

Where L_t is length at time t , L_{inf} is the maximum theoretical length (length infinity), e is the exponent for natural logarithms, k is the growth coefficient, t is age in years, and t_0 is the age when L_t is zero.

L_{inf} predicts the average ultimate length attained for fish in that population. Growth equations were calculated separately for each sex due to sex-specific growth differences.

Instantaneous mortality (Z) and annual mortality ($A = 1 - e^{-Z}$) were estimated using a catch curve regression fitted to those ages fully recruited to the gear (Miranda and Bettoli 2007).

Proportional size distribution (PSD) indices were used to describe population size structure of walleye, northern pike, largemouth bass, and bluegill (Guy et al. 2007). PSD values represent the percent of fish stock length or larger that are also larger also longer than a specified length (Appendix Table 1). The Fisheries Assessment Classification Tool (FACT) was used to determine how PSD values for largemouth bass and walleye compared to those from similar waterbodies throughout Wisconsin. In addition, the CPE for 8, 12, and 15 in (i.e., CPE8, CPE12, and CPE 15) largemouth bass were compared to similar waterbodies in Wisconsin. Relative Weight (Wr) was used to assess the condition level of gamefish species using their standard weight equations (Willis 1989; Murphy et al. 1990; Anderson and Neumann 1996). Relative weight is the ratio of a fish's weight to the weight of a "standard" fish of the same length.

Recreational Creel and Tribal Harvest:

A creel survey was completed on Bear Lake to assess the effort and harvest from recreational anglers. The creel survey began the first Saturday in May and went to the first Sunday in March of the following year (i.e., the Wisconsin gamefish season). However, no creel data were collected during November because of unsafe ice conditions. The creel survey was separated into the open water fishing and ice fishing periods. Creel survey methods followed a stratified random design as described by Rasmussen et al. (1998). The directed effort, catch, harvest, specific harvest rate, and mean length of harvested fish was evaluated for each species during the open water and ice fishing creel surveys. The angling exploitation rate for adult walleye was calculated by dividing the estimated number of marked adult walleye harvested by the total number

of adult walleye marked (R/M; Ricker 1975). Tribal exploitation was calculated as the total number of adult walleye harvested divided by the adult population estimate (C/N; Ricker 1975). Total adult walleye exploitation rates were calculated by summing angling and tribal exploitation.

Results

Early spring fyke netting and electrofishing

Walleye. We fished up to 14 fyke nets for 5 nights, which totaled to 62 net-nights. The walleye catch rate was 3.5 fish/net-night. We collected 179 walleyes fyke netting (Figure 2), 174 of which were adults that received marks. There were 26 males, 140 females, and 8 unknown sex walleye in the sample.

There were 106 walleye collected during the early spring electrofishing (recapture period), for a catch rate of 8.8 fish/mile. The electrofishing sample included 11 recaptured males, 24 unmarked males, 6 recaptured females, and 25 unmarked females. The adult walleye population estimate was 911 or 0.7 fish/acre (95% C.I. = 512-1,310; Figure 3), which was similar to 2008 when it was estimated at 661 or 0.5 fish/acre (95% C.I. 434-888).

Size structure of walleye has increased in Bear Lake. Walleye PSD from netting was 96 ± 3 , PSD-P was 44 ± 7 , and PSD-M was 19 ± 6 (Figure 4). These size structure indices were higher than previous netting surveys. When compared to statewide trends, the indices were also high; walleye PSD was in the 98th percentile, PSD-P was in the 81st percentile, and PSD-M was in the 92nd percentile. The male:female ratio was 0.3:1. Mean length of walleye (sexes pooled) from fyke netting was 19.8 in. The mean length of male walleye was 18.1 in and the mean length of female walleye was 21.5 in. Walleye *Wr* was 93, which suggested walleye were in average condition.

Walleye in Bear Lake had average growth rates. Mean length at age for walleye (sexes pooled) was similar to the Barron and Polk County average and the Northern Region average across all ages, and those from previous surveys (Table 3). Mean length at age of female walleye was greater than male walleye across all ages (Figure 5). The predicted length infinity (L_{inf}) from the von Bertalanffy growth model was 30.0 in for female walleye, and 21.2 in for male walleye.

Walleye were fairly long-lived. Walleye ages ranged from 2 to 18, male walleye ranged from age 3 to 16 and females ranged from 4 to 18. The catch curve regression model (fitted to age 4 to age 18) estimated annual mortality to be 22.0% ($Z = -0.25$, $R^2 = 0.75$; Figure 6).

Northern Pike. Catch of northern pike was relatively high during the spring fyke netting survey. There were 568 northern pike collected (528 excluding recaps; Figure 7). The catch rate was 9.2 fish/net-night, which was greater than the 2008 (3.2 fish/net-night), 2000 (5.2 fish/net-night), and 1996 (7.3 fish/net-night) surveys.

The size structure of northern pike was low, likely due to their high abundance. Northern pike PSD from netting was 24 ± 4 and the PSD-P was 2 ± 1 (Figure 8). The PSD was the highest it has been, but the PSD-P and PSD-M were similar to previous surveys. The PSD-P and PSD-M of northern pike has been low in all Bear Lake netting surveys. There were 243 males, 275 females, and 10 northern pike of unknown sex. Mean length of northern pike (sexes pooled) from fyke netting was 19.3 in ($SE=0.1$), northern pike ranged in length from 7.8 to 36.1 in. The mean length of male northern pike was 17.9 in ($SE=0.1$) and mean length of female northern pike was 20.2 in ($SE=0.2$). Northern pike Wr was 88 which suggested the northern pike are in below average condition.

Northern pike had slow growth rates. Mean length at age for northern pike (sexes pooled) was less than the Barron and Polk County and the Northern Region averages across nearly all ages (Table 4). Age 3 to 7 northern pike from Bear Lake were approximately 2.7 in less than the average length northern pike from Barron and Polk counties, and 0.6 in less than the Northern Wisconsin average over those same ages. The mean lengths at age reported for northern pike in this survey were lower for most ages compared to the 2008 and 1996 surveys, especially those 3 years and older. Age 3 to 7 northern pike collected in this survey averaged 2.4 in less than those from 2008 and 4.8 in less than those from 1996.

The predicted length infinity (L_{inf}) from the von Bertalanffy growth model was 35.1 in for female northern pike, and 27.4 in for male northern pike (Figure 9).

The mortality rate of northern pike was fairly high. Ages ranged from 1 to 10, while males ranged from age 1 to 10 and females ranged from 2 to 9. The catch curve

regression model (fitted to age 4 to age 10) estimated annual mortality to be 64.4% ($Z = -1.03$, $R^2 = 0.94$; Figure 10).

Late spring electrofishing

Largemouth Bass. The largemouth bass population was moderately abundant with fair size structure. There were 132 largemouth bass collected during the late spring electrofishing survey (Figure 11); the catch rate was 16.5 fish/mile which is a slight decrease from 2008 when it was 18.6 fish/mile, but was greater than the 1996 and 2000 surveys (Figure 12). The catch rate of largemouth bass in Bear Lake was moderate when compared to similar waterbodies in Wisconsin. The CPE8 (15.1 fish/mile), CPE12 (7.4 fish/mile), and CPE15 (1.6 fish/mile) were in the 41st, 51st, and 34th percentiles, respectively.

Largemouth bass PSD was 49 ± 9 , and the PSD-P was 11 ± 5 (Figure 13). The PSD and PSD-P have decreased since 2008, and are the lowest they have been since 1990. The largemouth bass PSD was in the 28th percentile for similar waterbodies in Wisconsin. Largemouth bass ranged in length from 5.9 to 17.5 in, and the mean length was 11.7 in. Largemouth bass Wr was 106, which suggests the largemouth bass were in above average condition.

Growth rates of largemouth bass have decreased on Bear Lake. The mean length at age was at an all-time low for nearly all ages when compared to previous surveys. Mean length at age for all age classes age 4 and older were less than those from the 1996 and 2008 surveys, the Barron and Polk County average, and also the Northern Region average (Table 5). The von Bertalanffy growth model was not able to produce a logical L_{inf} .

Largemouth bass were relatively short-lived. Ages of largemouth bass ranged from 2 to 9. An annual mortality estimate was not able to be determined from the catch curve regression model.

Smallmouth Bass. Smallmouth bass were not as abundant as largemouth bass in the late spring electrofishing sample. There were 13 smallmouth bass collected, which resulted in a catch rate of 1.6 fish/mile (Figure 14). Smallmouth bass ranged in length from 8.7 to

13.4 in, and the mean length was 10.9 in. Ages of smallmouth bass ranged from age 3 to age 5.

Bluegill. There were 277 bluegill collected during the late spring electrofishing survey (Figure 15). The catch was 138.5 fish/mile. Total length of bluegill ranged from 2.1 to 8.2 in, and the mean length was 5.6 in.

The size structure and growth rates of bluegill in Bear Lake were fair. The PSD was 44 ± 6 and PSD-P was 2 ± 2 . Bluegill growth has declined from the 1996 survey (i.e., most recent survey with bluegill aging data) and was also lower than the Barron and Polk County average and the Northern Wisconsin average across all ages (Table 6). More specifically, the mean length at age of bluegill (across all ages) in this survey averaged 0.6 in less than 1996 and the Barron and Polk County average, and averaged 0.9 in less than those from the Northern Wisconsin average.

Other panfish. There were 33 pumpkinseeds sampled during the late spring electrofishing, for a catch rate of 16.5 fish/mile (Figure 16). The mean TL was 6.3 in with a range of 4.0 to 7.9 in.

Fifty six rock bass were collected for a catch rate of 26.0 fish/mile (Figure 17). The mean length was 5.8 in with a range of 3.0 to 9.0 in.

Four black crappies were collected which resulted in a catch per effort of 2.0 fish/mile. The mean length was 8.0 in with a range of 5.3 in to 10.5 in.

There were 39 yellow perch collected for a catch rate of 19.5 fish/mile (Figure 18). The mean length of perch was 4.9 in with a range of 2.8 in to 11.4 in

Fall Electrofishing

Walleye recruitment. No age-0 or age-1 walleye were collected during the fall electrofishing survey (Table 7). Catch rates of age-0 and age-1 walleye have historically been low in Bear Lake, despite intensive stocking efforts. The only time the catch rate of age-0 walleye exceeded 2.0 fish/mile was in 2010; however, the 2010 survey occurred after large fingerlings were stocked that fall.

Fry and small fingerling stockings have failed to produce measureable year-classes. Comparing fall catch rates of age-0 and age-1 walleye to walleye stocking indicates no consistent pattern of stronger year-classes during stocked years or in years with higher stocking rates. Although the Bear Lake walleye fishery is stocking dependent, there is a low level of natural reproduction that occurs, as evidenced by the presence of age-0 walleye in non-stocked years (i.e., 2011) and age-1 walleye the year following a non-stocked year (i.e., 2006).

Recreational Creel and Tribal Spearing

Open water angling effort amounted to 20,241 hours (14.9 hr/acre), which is less than all previous creel surveys (Table 8). Ice angling effort amounted to 4,753 hours (3.5 hr/acre), which was also less than previous creel surveys. The projected angling effort on Bear Lake during the 2014-2015 fishing season was 24,994 hours (18.4 hr/acre), which was the least amount of fishing effort documented for Bear Lake.

Walleye. Fishing effort directed toward walleye accounted for only 12.6% of the total effort during the open water, and 15.5% during the ice fishing season. Projected angler catch of walleye was 943 fish (0.7 fish/acre), and the angler walleye harvest estimate was 220 fish (0.2/acre), which is similar to previous creel surveys (Tables 9, 10, & 11). Mean length of walleye harvested was 19.0 in during the open water season and 18.3 in during the ice fishing season.

No walleye were speared by tribal spearers, which made recreational angling the sole source of exploitation. The recreational angling walleye exploitation rate was 13.7%

Panfish. A considerable amount of the total angling effort was directed toward panfish (bluegill, black crappie, pumpkinseed, and yellow perch) during the open water (61.7%) and ice fishing seasons (44.3%; Tables 9 & 10). Anglers directed the most effort at black crappie (26.1%) and bluegill (25.8%) during the open water season. Similarly, bluegill and black crappie ranked high during the ice fishing creel survey also. Bluegill received 26.9% of the effort and black crappies were less sought after during the ice fishing creel survey and received 15.6% of the effort. Bluegill was the most caught and harvested

species during the open water and ice fishing creel seasons. The projected catch of bluegill was 31,918 (23.5 fish/acre) and the projected harvest was 19,916 (14.7 fish/acre), both statistics are the lowest on record (Table 11). The mean length of harvested bluegill was 7.4 in during the open water season and 7.1 in during the ice fishing season. Anglers caught and harvested black crappies in higher levels than previously documented on Bear Lake. There were 14,993 black crappies (11.0 fish/acre) estimated to be caught and 11,529 (8.5 fish/acre) harvested. The mean length of black crappie harvested was 10.0 in during the open water season and 10.3 in during the ice fishing season. Although pumpkinseed and yellow perch represented a minor part of the overall fishery, they complimented the panfish opportunities in Bear Lake.

Largemouth bass. Largemouth bass comprised a respectable portion of the open water creel and received 14.9% of the angler effort. Largemouth bass made up a smaller component of the ice fishing creel and received 7.8% of the effort. Projected annual catch and harvest of largemouth bass was approximately twice as much as previous surveys. We estimated that 8,203 largemouth bass (6.0 fish/acre) were caught of which 1,381 (1.0/acre) were harvested. The increase in harvest of bass is at least partly due to the no minimum size limit and 5 fish daily bag limit on largemouth bass that was implemented in 2011. This regulation enabled anglers to harvest largemouth bass that were previously protected. Of the largemouth bass harvested during this survey, 23.0 % of them were less than 14 inches and would have been protected with the previous regulation (Figure 19). Comparing the relative distribution of bass harvested on Bear Lake with what was captured during the late spring electrofishing survey indicated that anglers tended to harvest larger bass. The mean length of largemouth bass harvested was 14.6 in during the open water creel and 16.2 in during the ice fishing creel.

Northern Pike. Northern pike were the most targeted species during the winter creel and received 32.4% of the effort, but played a lesser role in the open water creel where only 9.6% of the effort was directed to them. There were 5,981 northern pike (4.4/acre) estimated to be caught, and 1,142 (0.8/acre) harvested. The catch of northern pike has decreased from recent surveys, but the harvest is similar. Mean length of northern pike

harvested was 21.8 in during the open water season and 23.7 in during the ice fishing season.

Summary and Discussion

Similar to previous Bear Lake surveys, northern pike were the most abundant gamefish species, with moderate walleye and largemouth bass populations (Cornelius 1998; Cornelius 2002). Walleye had high size structure with good growth rates, whereas largemouth bass and northern pike had moderate to poor size structure with below average growth rates.

The walleye population in this survey was similar to population from the 2008 survey. The current population is considered a low density walleye population which is not unusual for Bear Lake, as the walleye population has always been a lower density (<1.5 fish/acre) population. The low density walleye population is likely driven by a lack of recruitment and not overharvest. This lack of recruitment has occurred despite extensive walleye stocking efforts with fry, small fingerlings, and low levels of large fingerlings.

The size structure of walleye was fairly well represented; however, the sex ratio of male:female walleye has shifted greatly from 5.6:1 in the 2008 survey to 0.3:1 in this survey. A healthy walleye population should have a higher male:female ratio, similar to the 2008 survey. Low density walleye populations with low male:female ratios are often considered populations that have had minimal recruitment and are on the verge of collapse; however, that does not seem to be the case on Bear Lake. The low male:female sex ratio in this survey was unusual because there was decent representation of age classes. This change in sex ratio, likely had an effect on the size structure indices in this survey, as most of the fish in the sample were larger female walleye. Bear Lake walleye had growth rates similar to previous surveys and the regional averages; however, they were long lived and reached high L_{inf} , making Bear Lake a good option for anglers interested in larger walleye.

Although natural reproduction has been documented on Bear Lake, the recruitment of naturally-reproduced walleye has occurred at relatively low levels over the years. There has not been a strong naturally-reproduced year-class on Bear Lake. The

most recent indication of natural reproduction was during the 2011 fall survey, but that age-0 walleye catch rate was 0.17 fish/mile. It is likely unrealistic to expect a significant level of walleye recruitment, when it has not been documented in the past. With the lack of natural walleye recruitment, there have been extensive stocking efforts for Bear Lake, but the catch of age-0 and age-1 walleye has remained low even during stocked years. Of the 16 fall electrofishing surveys that have occurred since 1988, the mean catch rate of age-0 walleye has been 0.54 fish/mile. This is a very low catch rate, considering from 1990 to 2012 the average fall catch rate of age-0 walleye in the Ceded Territory was 31.8 fish/mile in naturally-reproducing populations and 5.6 fish/mile in stocked populations (Cichosz 2015). The highest catch rate of age-0 walleye was in 2010 (3.13 fish/mile); however, that fall survey occurred days after a large fingerling walleye stocking event. The catch rates of age-1 walleye has also been low during those same surveys (mean=0.41 fish/mile). The highest age-1 catch rate was documented in 2011, which likely coincided with the large fingerling stocking in 2010; however, there have been several other large fingerling stockings since then and the age-1 catch rate the following year has stayed low.

Since there has been minimal return from fry and small fingerling stockings, future stocking efforts should continue to focus on large fingerlings. Beginning in 2014 Bear Lake was selected to get stocked with large fingerling walleye at a rate of 20 fish/acre, which is the highest WDNR stocking rate for large fingerling walleye. Special attention should be given to the response of the walleye population from this increased stocking rate during the next comprehensive survey and annual fall recruitment surveys. If the walleye population does not improve to a density of 1.5-2 adults/acre, Bear Lake walleye stocking should be reduced or discontinued. No changes should be made to the walleye regulation or current stocking rates.

The current largemouth population is characterized as a moderate density, low size structure population. The electrofishing catch rate of largemouth bass was slightly less in this survey compared to 2008. Catch rates have been relatively low over the years on Bear Lake, especially compared to other lakes; however, even with the low catch rate the mean length at age is still below the Barron and Polk County and Northern Region averages. The mean length at age for bass in this survey declined for nearly all ages and

was at an all-time low from previous surveys, which would suggest their density is increasing and their growth is slowing. Largemouth bass were aged with scales and dorsal spines, which can have their limitations especially with slower growing populations. It would be beneficial to take an otolith sample from Bear Lake largemouth bass to get improved age, growth, and mortality estimates for this population.

This was the first creel survey for Bear Lake since the no minimum length limit for largemouth bass was implemented. It is evident that Bear Lake anglers are receptive to harvesting largemouth bass because more bass were harvested during this survey than previously documented. However, only 23.0% of the largemouth bass harvested in this survey were less than 14 in and would have previously been protected with the statewide regulation. This is quite the contrast from another 2015-2015 creel survey on Balsam Lake (Polk County, WI), that also had a no minimum length limit bass recently implemented, where 60.5% of largemouth bass harvested were less than 14 in (Cole 2016).

Based on the comparison of the relative frequency of harvested bass to those sampled in this survey, it appears that anglers are disproportionately harvesting the largest bass in Bear Lake. If anglers harvest high numbers of largemouth bass >14 in, the size structure could potentially continue to decline. Along with the decreased largemouth bass catch rates we found a largemouth bass population with lower size structure during the late spring electrofishing survey. Anglers are encouraged to continue to harvest largemouth bass, especially those less than 14 in. If the number of small (<14 in) largemouth bass can be reduced, the size structure and growth rates of the largemouth bass population should improve. The largemouth bass fishery should continue to be managed with the no minimum length limit; however, special attention should be given to the abundance, growth, and size structure of the largemouth bass population during the next comprehensive survey. If the size structure of largemouth bass continues to decline, a different regulation should be considered, possibly the no minimum, 14-18 in protected slot, 1 > 18 in; 5 fish daily bag limit.

There continues to be a low density smallmouth bass fishery present in Bear Lake. This population is present at low levels and provides more of a background fishery. No management actions are warranted to the smallmouth bass population.

Northern pike remain the dominant gamefish species in Bear Lake, which follows what was found in previous surveys (Cornelius 1998; Cornelius 2002). Although we did not conduct a population estimate on the northern pike population, the catch rate of northern pike during the spring fyke netting survey has increased from previous surveys, which suggests the northern pike population has increased. Along those same lines, the mean length at age of northern pike has decreased across nearly all ages, which further suggests an increase in the northern pike population.

Bear Lake has a high density, low size structure northern pike population, which is similar to what was documented in previous Bear Lake surveys. Bear Lake is a fertile lake with a strong population of cisco, an important forage fish; and should be capable of growing more large northern pike.

Other regulatory options such as a protected slot limit or a maximum length limit should be considered to help address the poor size structure of northern pike. Increasing the harvest of smaller ($<24''$) northern pike and preserving the size structure of large northern pike has the potential to increase the overall size structure of the population. Pierce (2010) evaluated various length limits in Minnesota and found that 20, 22, and 24-in maximum length limits for northern pike significantly improved the size structure of northern pike by increasing the proportions of large fish. The average increase in the percentage of fish ≥ 24 in was 18% in lakes with a maximum length limit (compared with 2% in the reference lakes). Similarly, the average increase in the percentage of northern pike ≥ 30 in was 5.1% in regulation populations, (compared with 0.7% in reference populations). In contrast, 6.3% of the 528 northern pike collected in fyke nets during this survey were ≥ 24 in, and 1.1% were ≥ 30 in.

Despite their low size structure, northern pike are an important species in the Bear Lake sport fishery, especially during winter where they were the most targeted species during the winter creel. Anglers were willing to harvest smaller (<24 in) northern in Bear Lake during this survey because the average length of northern pike harvested was 21.8 in during the open water season and 23.7 in during the ice fishing season. A maximum length limit or a protected slot limit would continue to allow harvest opportunities for Bear Lake northern pike. Although the northern pike population is less than the desirable

size, anglers are encouraged to increase harvest of small northern pike. If harvest of small northern pike was increased, size structure of northern pike would likely improve.

In the last survey, it was speculated that largemouth bass could be reducing walleye stocking success (Benike 2010). Largemouth bass may have some role in the lack of walleye stocking success in Bear Lake. However, in the case of Bear Lake, the largemouth bass population is considered moderate and northern pike are abundant. The abundant northern pike population could be affecting the stocking success of walleye more than previously noted. If anglers harvested more small northern pike, walleye recruitment and stocking survival could potentially improve also.

Panfish continue to be an important component of the Bear Lake fishery, as the majority of the angling effort on Bear Lake is typically directed at panfish species. There was a respectable year-class of black crappie present during this survey. Black crappies were not sampled well during the late spring electrofishing survey, but comprised a large portion of the creel, especially during the open water season. Crappie populations naturally fluctuate from differences in year-class strength, and the population during this survey seemed to be greater than normal. Although bluegill were found to have average size structure and slow growth, they were the most caught and harvested species during the open water and ice fishing creel seasons. Despite their popularity among Bear Lake anglers, the projected catch and projected harvest of bluegill were lower than previous surveys. The less than desired size structure and growth rates of Bear Lake bluegill is likely due to the abundance of submerged macrophytes in Bear Lake, which provides hiding cover. Abundant macrophytes decrease the risk of predation of bluegill by largemouth bass (Savino and Stein 1982). When the risk of predation decreases, the size of the population will increase and their size structure should decrease. No management actions are recommended for Bear Lake panfish species.

For its size, Bear Lake is rather lightly developed compared to other lakes in Barron and Polk Counties. Bear Lake has good water quality and fish habitat with the aquatic plant community and associated wetlands. Protecting the existing habitat and restoring and minimizing lakeshore development will greatly benefit the Bear Lake fish community, and the overall health of the lake into the future.

Management Recommendations

1. Maintain the walleye density between 1.5-2 fish/acre through stocking large fingerling (6-8 in) walleye at a rate of 20 fish/acre. A better assessment will be made on the relative contribution of the large fingerlings during the annual fall electrofishing surveys and comprehensive surveys.
2. Walleye stocking efforts should focus solely on large fingerling stockings due to the poor return from stocking fry and small fingerling walleye.
3. A special fishing regulation such as a protected slot limit should be explored in an attempt to improve the size structure of northern pike.
4. Encourage continued harvest of largemouth bass less than 14 inches. Reducing the number of small largemouth bass should increase the size structure and growth rates of the population and may improve walleye stocking success.
5. Continue to monitor the abundance, size structure, and growth rates of the largemouth bass population during fall electrofishing surveys and the next comprehensive survey. It would be beneficial to collect otoliths from largemouth bass to better assess their age, growth, and mortality.
6. Through educational efforts, lakeshore property owners should be encouraged to minimize disturbance to the lakeshore and littoral zone, to protect both fish and wildlife habitat, and water quality.
7. The current invasive species education, monitoring, and prevention activities should continue.

Acknowledgements

Special thanks are extended to the Brian Spangler and Josh Kucko of the Barron field office with assistance in the field, data entry, and fish age estimation, as well as the staff with the Spooner treaty assessment unit, especially Gene Hatzenbeler, Misty Rood, Todd Brecka, and Jill Sunderland for data collection, data entry, and completion of the creel survey. Jeff Kampa provided a critical review of this manuscript.

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Table 1. Stocking history for Bear Lake, Barron County, WI, 1973-2014.

Stocking Year	Species Name	Size	Number Stocked
1973	Walleye	Small Fingerling	13,124
1974	Walleye	Small Fingerling	20,056
1975	Walleye	Small Fingerling	20,090
1976	Walleye	Small Fingerling	67,920
1978	Walleye	Small Fingerling	67,908
1980	Walleye	Small Fingerling	64,492
1982	Walleye	Small Fingerling	68,340
1984	Crappie	Adult	4,250
1984	Walleye	Small Fingerling	67,323
1985	Crappie	Adult	2,185
1985	Northern Pike	Fry	204,000
1986	Walleye	Small Fingerling	68,064
1988	Walleye	Small Fingerling	36,701
1988	Walleye	Fry	1,358,000
1989	Walleye	Small Fingerling	67,894
1989	Walleye	Fry	1,358,000
1991	Walleye	Small Fingerling	68,593
1992	Walleye	Small Fingerling	24,087
1993	Walleye	Small Fingerling	73,085
1995	Walleye	Small Fingerling	72,366
1996	Walleye	Small Fingerling	2,039
1997	Walleye	Small Fingerling	67,900
1998	Walleye	Small Fingerling	12,845
1999	Walleye	Small Fingerling	89,005
2000	Walleye	Small Fingerling	14,850
2001	Walleye	Small Fingerling	52,348
2001	Walleye	Small Fingerling	101,850
2003	Walleye	Small Fingerling	157,733
2004	Walleye	Fry	525,000
2004	Walleye	Small Fingerling	129,519
2006	Walleye	Large Fingerling	8,505
2008	Walleye	Small Fingerling	23,764
2009	Walleye	Large Fingerling	3,268
2010	Walleye	Large Fingerling	8,134
2012	Walleye	Large Fingerling	6,893
2012	Walleye	Small Fingerling	23,691
2013	Walleye	Small Fingerling	52,732
2014	Walleye	Large Fingerling	26,953

Table 2. Sampling effort for the 2014 Bear Lake comprehensive fisheries survey.

Date	Gear	Survey type	Effort
Apr 29, 2014 to May 4, 2014	Fyke nets	Walleye netting	62 net nights
May 4, 2014	Electrofishing	Walleye recapture	12.0 miles
June 9, 2014 to June 10, 2014	Electrofishing	Bass-Panfish electrofishing	8.0 miles
Sept. 22, 2014	Electrofishing	Age-0 walleye electrofishing	12.0 miles

Table 3. Mean length (in) at age for walleye (sexes pooled) in Bear Lake, 1996-2014, the Barron and Polk County average, and the northern Wisconsin (NOR) average.

Age	1996	2000	2008	2014	Barron & Polk	NOR
1	6.1	6.7	—	—	7.5	6.4
2	9.5	10.8	—	10.4	10.9	9.5
3	12.4	13.3	—	14.6	13.9	11.7
4	15.1	15.2	14.4	16.8	15.6	13.8
5	17.8	17.9	14.8	17.7	17.8	15.8
6	20.4	19.0	19.8	18.4	19.0	17.5
7	22.9	19.8	22.3	22.1	20.8	19.1
8	23.7	22.7	21.2	22.1	21.8	20.5
9	22.9	21.7	24.1	22.9	22.5	21.6
10	23.4	23.1	24.0	22.0	23.3	22.7
11	25.2	23.1	20.8	24.2	23.9	23.7
12	22.7	28.5	25.7	24.4	25.1	24.4
13	25.6	25.5	—	26.5	25.2	25.2
14	23.8	27.4	26.6	25.4	24.8	25.8
15	24.0	24.1	—	25.6	25.6	25.6
16	25.5	26.0	—	25.2	25.2	25.6
17	—	25.4	—	29.7	27.0	25.2
18	22.1	—	—	29.5	25.5	25.6
19	27.9	30.4	—	—	—	—

Table 4. Mean length (in) at age for northern pike in Bear Lake, from 1996-2014, the Barron and Polk County average, and the northern Wisconsin average.

Age	1996	2008	2014	Barron and Polk	NOR
1	9.1	9.3	10.0	10.8	10.6
2	14.6	14.1	14.1	15.9	13.1
3	18.3	18.1	17.0	19.6	16.3
4	21.1	19.9	18.8	21.4	19.5
5	25.8	23.3	21.2	24.2	22.0
6	30.3	25.5	23.9	26.5	24.5
7	35.3	31.9	26.1	28.9	27.7
8	—	32.0	34.3	32.1	30.3
9	—	—	27.2	34.1	31.5
10	—	—	29.9	35.1	34.1

Table 5. Mean length (in) at age for largemouth bass in Bear Lake, from 1996-2014, the Barron and Polk County average, and the northern Wisconsin average.

Age	1996	2008	2014	Barron & Polk	NOR
1	5.0	—	—	4.2	4.7
2	7.6	7.3	7.3	6.8	6.7
3	9.6	9.4	8.9	8.9	9.0
4	12.0	11.0	10.0	10.9	11.0
5	13.2	12.3	11.6	12.5	12.7
6	14.5	13.9	12.8	13.9	14.6
7	15.9	14.7	14.3	14.9	16.0
8	16.1	15.9	15.6	16.0	17.3
9	17.5	17.2	16.4	17.0	18.1
10	16.3	18.2	—	17.5	18.8
11	—	—	—	18.5	19.4
12	16.5	—	—	18.7	19.6

Table 6. Mean length (in) at age for bluegill in Bear Lake, from the 1996 and 2014 comprehensive surveys, the Barron and Polk County average, and the northern Wisconsin average.

Age	1996	2014	Barron & Polk	
			Polk	NOR
1	2.7	2.2	2.3	2.4
2	3.3	2.8	3.4	3.7
3	4.3	3.6	4.3	4.7
4	5.4	4.3	5.4	5.6
5	6.2	5.3	6.2	6.5
6	7.0	6.3	6.9	7.1
7	7.6	7.0	7.4	7.7
8	8.0	7.9	7.8	8.2
9	—	7.8	8.4	8.8

Table 7. Fall electrofishing catch rates of age-0 and age-1 walleye in Bear Lake with walleye stocking history. An asterisk denotes a non-stocked year. A hyphen denotes a non-sampled year. Sampling occurred prior to stocking in 2014.

Stocking Year	Size Stocked	Number Stocked	Age-0 / mile	Age-1 / mile
1988	Small Fingerling	36,701	—	—
1988	Fry	1,358,000	0.17	0.00
1989	Small Fingerling	67,894	—	—
1989	Fry	1,358,000	—	—
1991	Small Fingerling	68,593	—	—
1992	Small Fingerling	24,087	0.68	1.06
1993	Small Fingerling	73,085	—	—
1995	Small Fingerling	72,366	—	—
1996	Small Fingerling	2,039	0.38	0.38
1997	Small Fingerling	67,900	—	—
1998	Large Fingerling	12,845	—	—
1999	Small Fingerling	89,005	0.41	0.14
2000	Large Fingerling	14,850	0.00	0.08
2001	Small Fingerling	154,198	0.94	0.00
2002	*	*	0.00	0.00
2003	Small Fingerling	157,733	0.27	0.00
2004	Fry	525,000	1.90	0.00
	Small Fingerling	129,519		
2005	*	*	0.00	0.14
2006	Large Fingerling	8,505	0.60	0.13
2008	Small Fingerling	23,764	0.00	0.08
2009	Large Fingerling	3,268	—	—
2010	Large Fingerling	8,134	3.13	0.78
2011	*	*	0.17	3.17
2012	Large Fingerling	6,893	—	—
	Small Fingerling	23,691		
2013	Small Fingerling	52,732	0.00	0.63
2014	Large Fingerling	26,953	0.00	0.00

"*" Denotes non-stocked year

"—" Denotes no sampling

Table 8. Recreational creel survey total angling effort and effort per acre for Bear Lake, Barron County, WI, 1996-2014.

Year	Open Water Fishing		Ice Fishing		Entire Season	
	Hours	Hours/acre	Hours	Hours/acre	Hours	Hours/acre
1996	26,532	19.5	10,244	7.5	36,776	27.1
2000	33,579	24.7	9,408	6.9	42,987	31.7
2008	32,676	24.1	14,341	10.6	47,017	34.6
2014	20,241	14.9	4,753	3.5	24,994	18.4

Table 9. Directed effort, catch, harvest, specific harvest rate, and mean length of harvested fish by species during the 2014-2015 Bear Lake open water creel survey.

Species	Directed Effort		Catch	Harvest	Harvest/Hour	Mean Length (inches)
	(Hours)	(%)				
Black Crappie	9,796	26.1%	14,034	11,070	1.13	10.0
Bluegill	9,685	25.8%	22,976	15,828	1.63	7.4
Largemouth Bass	5,583	14.9%	7,970	1,236	0.20	14.6
Walleye	4,720	12.6%	860	217	0.04	19.0
Northern Pike	3,613	9.6%	4,891	741	0.20	21.8
Yellow Perch	2,566	6.8%	988	195	0.06	9.8
Pumpkinseed	1,118	3.0%	108	108	0.10	7.4
Smallmouth Bass	498	1.3%	87	0	0.00	—
Rock Bass	—	—	260	0	—	—
Black Bullhead	—	—	40	5	—	11.0
Bowfin	—	—	32	0	—	—
Green Sunfish	—	—	12	0	—	—

Table 10. Directed effort, catch, harvest, specific harvest rate, and mean length of harvested fish by species during the 2014-2015 Bear Lake ice fishing creel survey.

Species	Directed Effort		Catch	Harvest	Harvest/Hour	Mean Length (inches)
	(Hours)	(%)				
Northern Pike	3,103	32.4%	1,090	401	0.13	23.7
Bluegill	2,574	26.9%	8,942	4088	1.59	7.1
Black Crappie	1,491	15.6%	959	459	0.31	10.3
Walleye	1,490	15.5%	83	3	0.00	18.3
Largemouth Bass	751	7.8%	238	145	0.16	16.2
Yellow Perch	175	1.8%	686	35	0.01	9.4

Table 11. Estimated catch/acre and harvest/acre (in parentheses) of sportfish by angling, Bear Lake, Barron County, WI, 1996-2014.

Year	Species								
	Black Crappie	Bluegill	Largemouth Bass	Northern Pike	Pumpkinseed	Rock Bass	Smallmouth Bass	Walleye	Yellow Perch
1996	4.2 (2.9)	26.4 (15.2)	2.3 (0.4)	7.0 (0.7)	0.3 (0.2)	0.5 (0.1)	0.5 (0.1)	1.5 (0.3)	4.2 (1.3)
2000	7.0 (4.5)	51.3 (25.3)	3.2 (0.3)	8.2 (1.4)	2.6 (1.7)	2.3 (0.4)	0.6 (0.1)	0.8 (0.3)	7.2 (1.6)
2008	21.0 (7.7)	63.3 (24.3)	4.8 (0.5)	7.6 (1.0)	2.7 (1.4)	—	0.3 (0.0)	1.0 (0.2)	3.8 (0.5)
2014	11.0 (8.5)	23.5 (14.7)	6.0 (1.0)	4.4 (0.8)	0.1 (0.1)	0.2 (0.0)	0.1 (0.0)	0.7 (0.2)	1.2 (0.2)

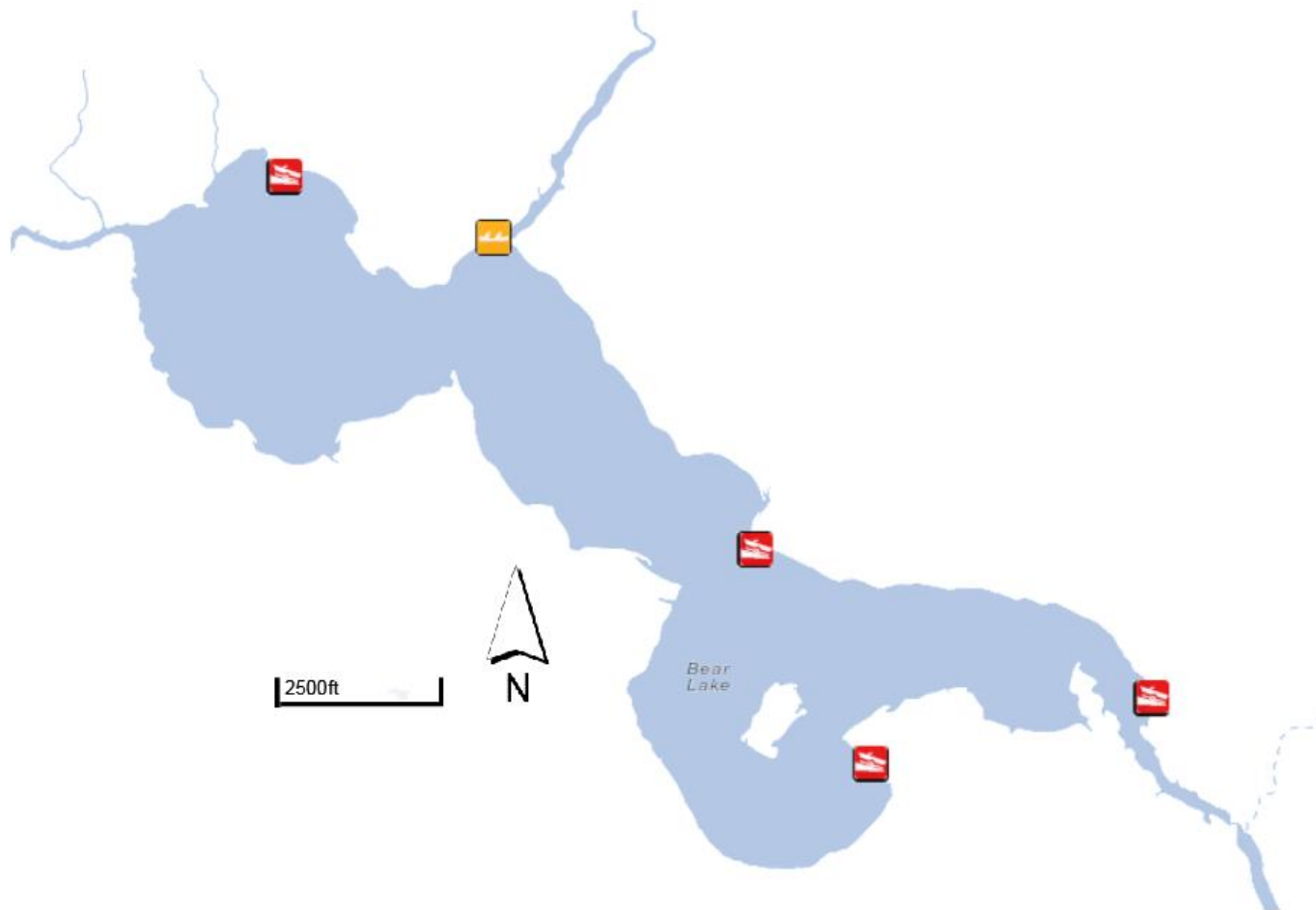


Figure 1. Map of Bear Lake, Barron County, Wisconsin.

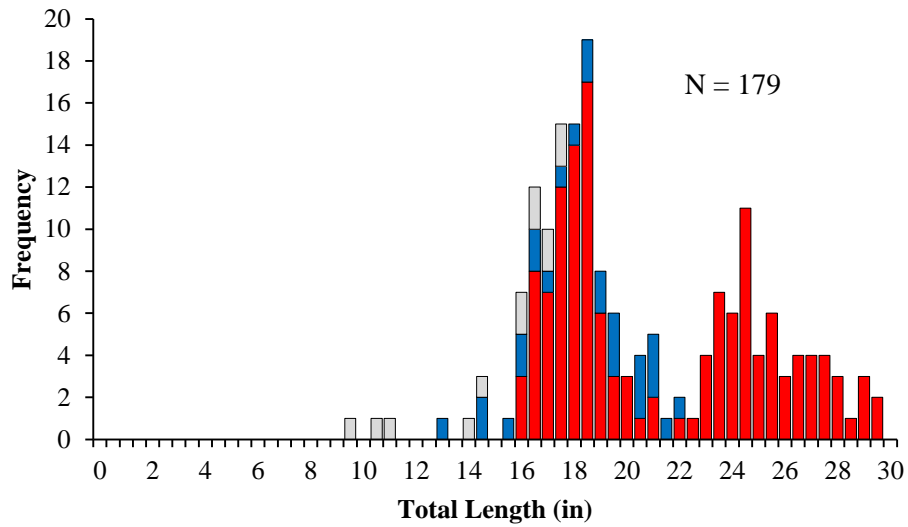


Figure 2. Length frequency histogram for walleye captured with fyke nets in Bear Lake, Barron County, WI, 2014. Gray bars represent walleye of unknown sex, blue bars represent male walleye, and red bars represent female walleye.

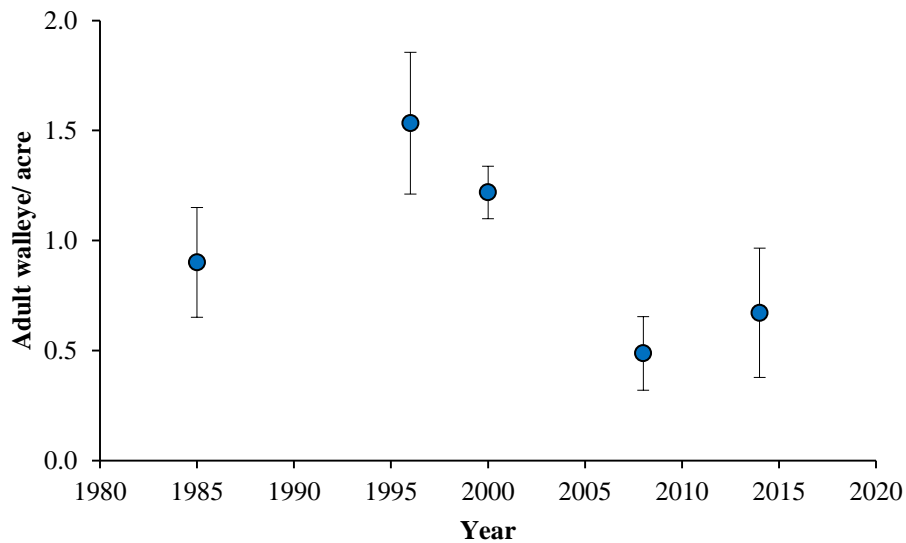


Figure 3. Population estimates for adult walleye (with 95% confidence intervals) in Bear Lake, Barron County, WI, 1986-2014.

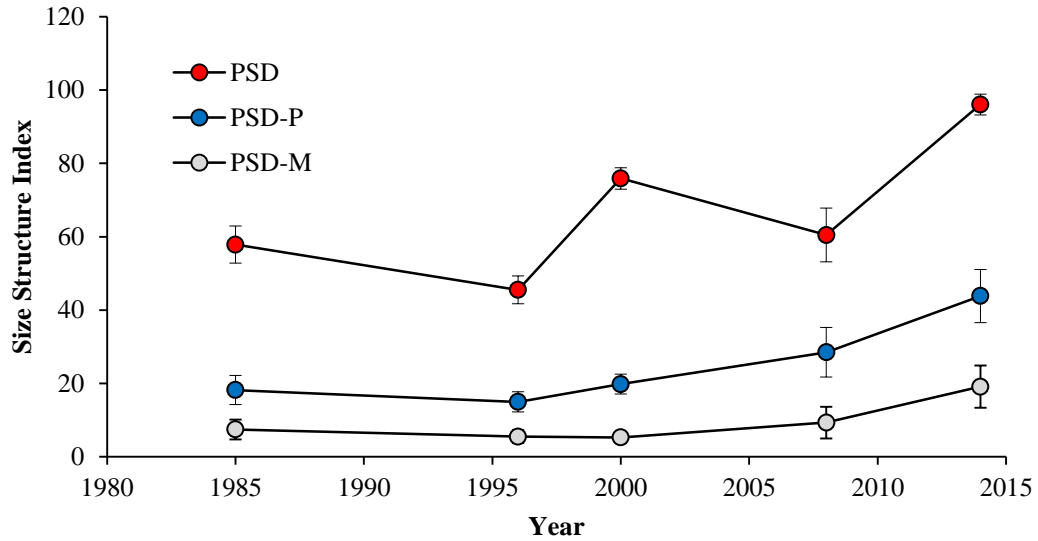


Figure 4. PSD, PSD-P, and PSD-M size structure index values (with 95% confidence intervals) for walleye collected from fyke nets in Bear Lake, Barron County, WI, 1985-2014.

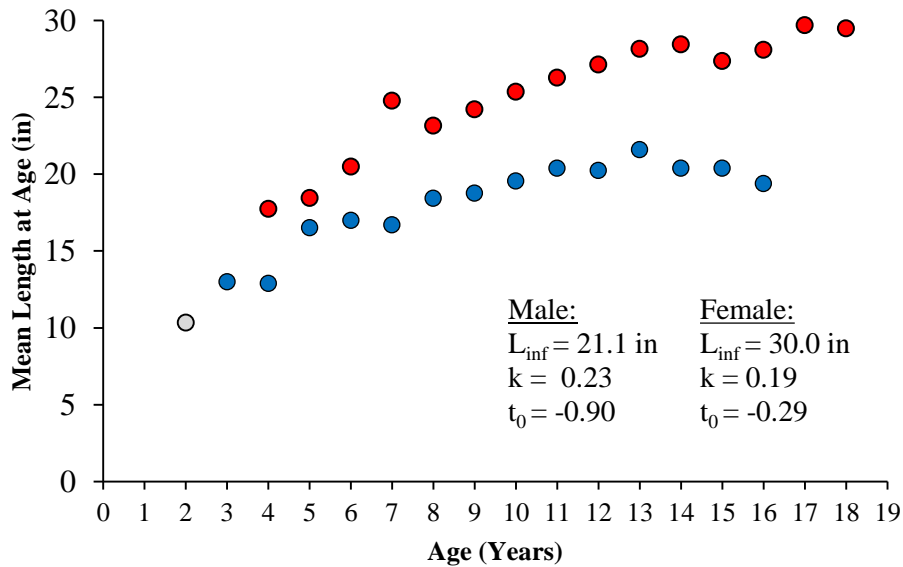


Figure 5. Mean length at age for female (red circles), male (blue circles), and unknown sex (gray circle) walleye collected from Bear Lake, Barron County, WI, 2014. Mean length at age of age-2 unknown sex walleye was included for both growth equations. L_{inf} = theoretical maximum length, k = growth coefficient, and t_0 = time at which length is zero.

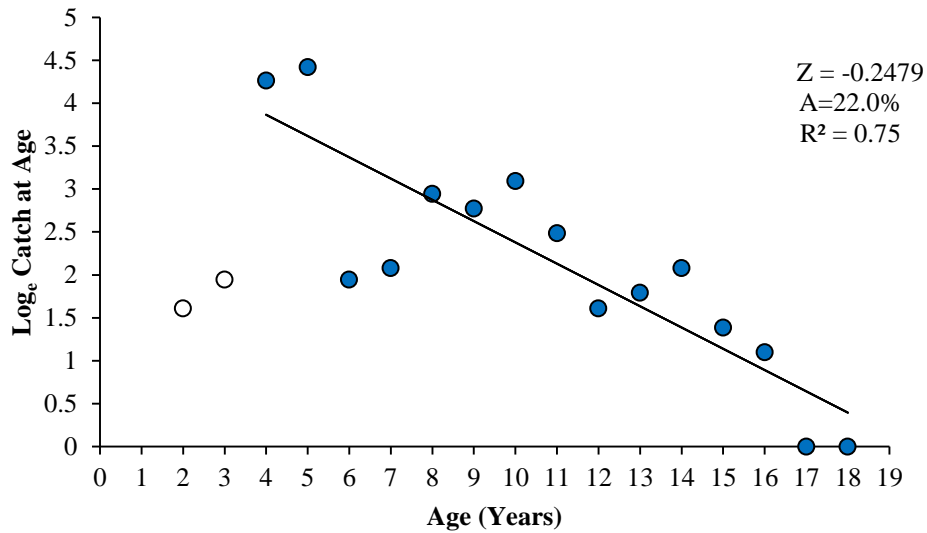


Figure 6. Number at age for walleye collected from Bear Lake, Barron County, WI, 2014. A catch-curve regression estimated instantaneous annual mortality (Z) and total annual mortality (A). Age-2 and age-3 were omitted from the regression.

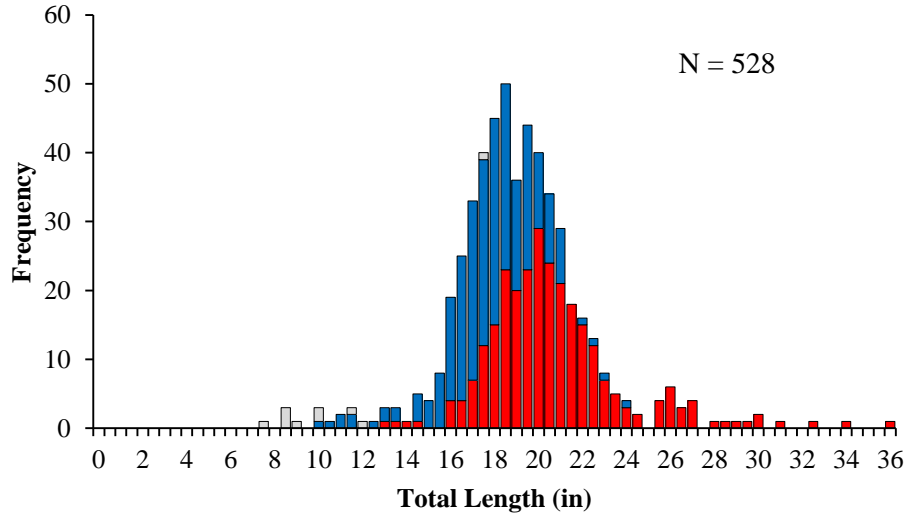


Figure 7. Length frequency histogram for northern pike captured during early spring fyke netting Bear Lake, Barron County, WI, 2014. Gray bars represent northern pike of unknown sex, blue bars represent male northern pike, and red bars represent female northern pike.

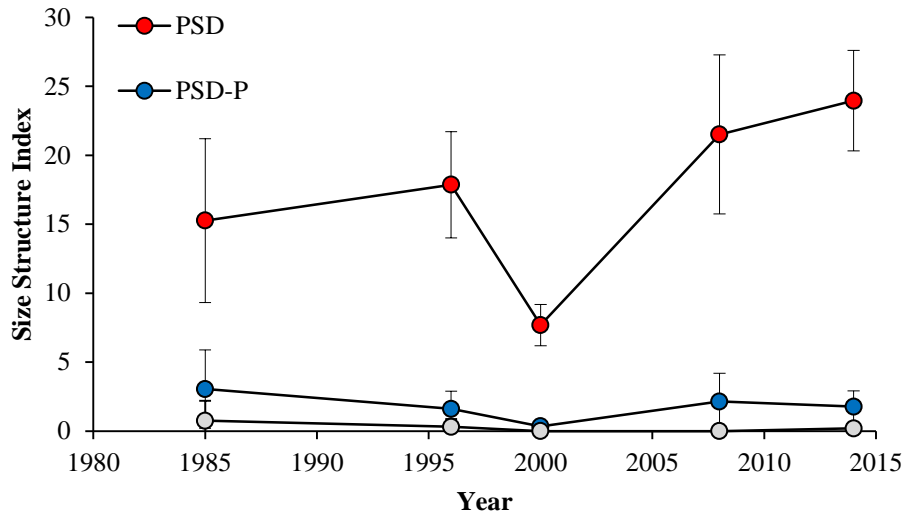


Figure 8. PSD, PSD-P, and PSD-M size structure index values (with 95% confidence intervals) for northern pike collected from fyke nets in Bear Lake, Barron County, WI, 1985-2014.

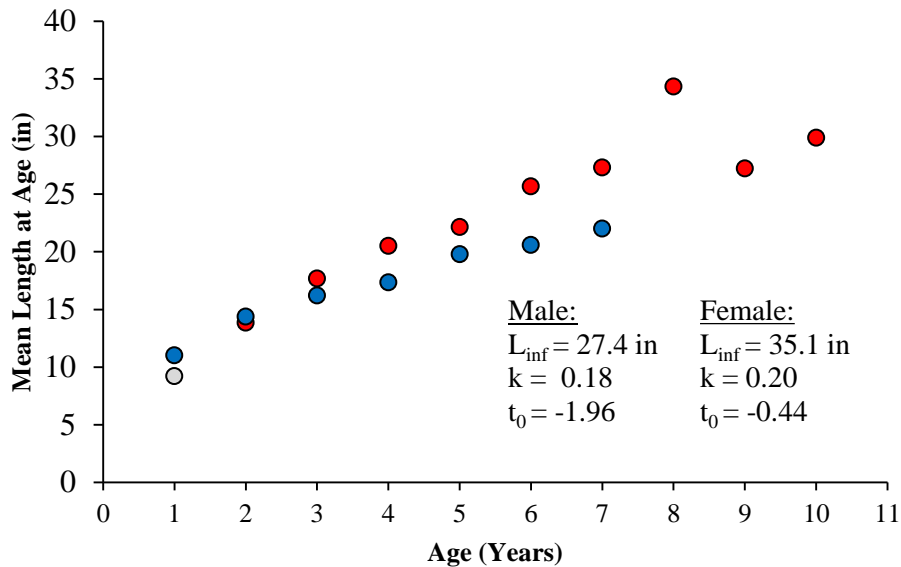


Figure 9. Mean length at age for female (red circles), male (blue circles), and unknown sex (gray circle) northern pike collected from Bear Lake, Barron County, WI, 2014. Mean length at age of age-2 unknown sex northern pike were included for the female growth equation. L_{inf} = theoretical maximum length, k = growth coefficient, and t_0 = time at which length is zero.

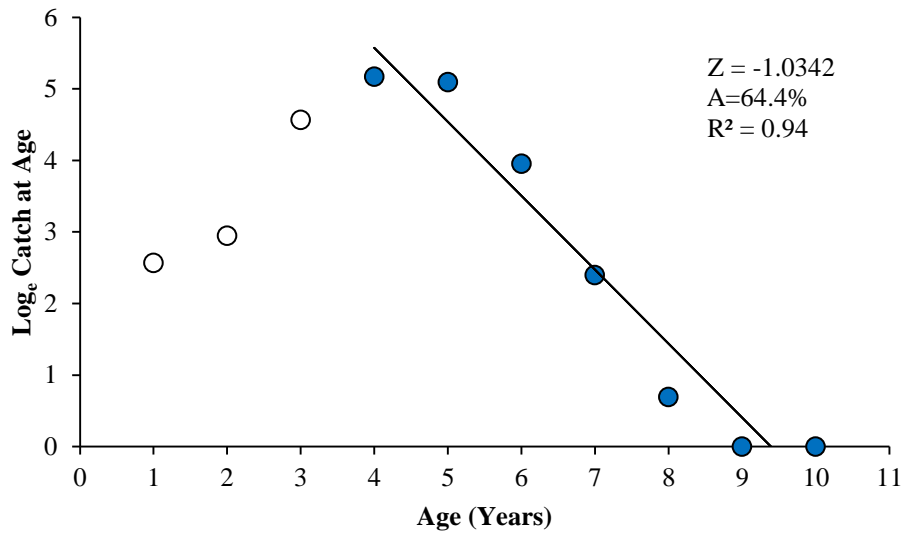


Figure 10. Number at age for northern pike collected from Bear Lake, Barron County, WI in 2014. A catch-curve regression estimated instantaneous annual mortality (Z) and total annual mortality (A). Age-1 to age-3 were omitted from the regression.

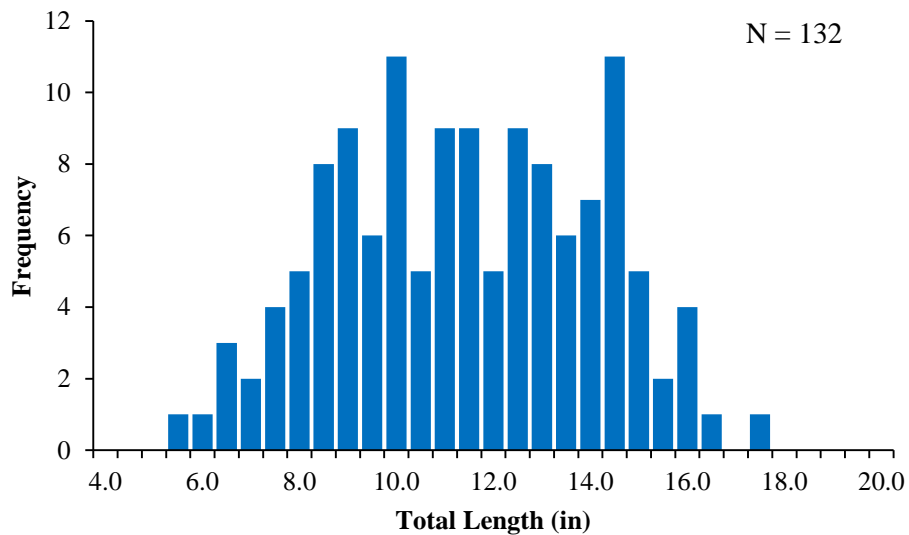


Figure 11. Length frequency histogram for largemouth bass captured during late spring electrofishing in Bear Lake, Barron County, WI, 2014.

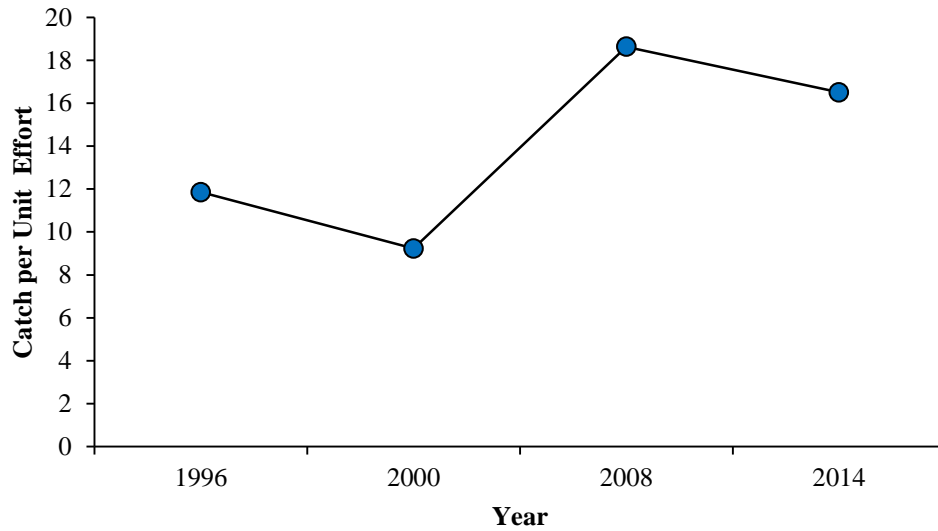


Figure 12. Catch per effort for largemouth bass collected during late spring electrofishing surveys from Bear Lake, Barron County, WI, 1996-2014.

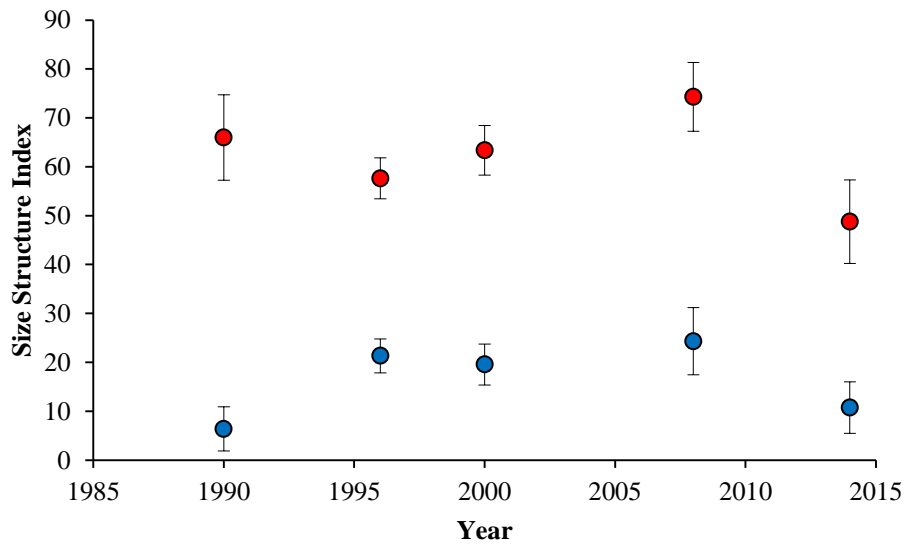


Figure 13. PSD (red circles) and PSD-P (blue circles) size structure index values (with 95% confidence intervals) for largemouth bass collected electrofishing in Bear Lake, Barron County, WI, 1990-2014.

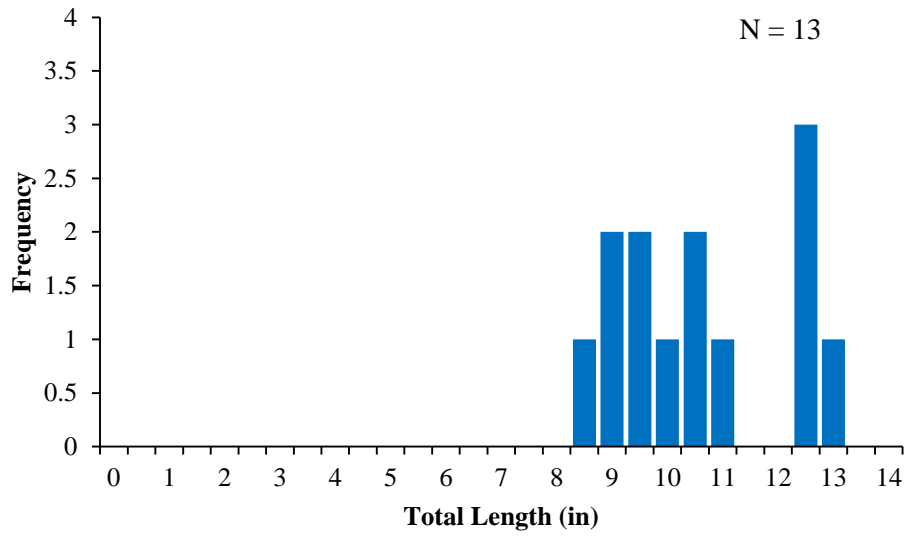


Figure 14. Length frequency histogram for smallmouth bass captured during late spring electrofishing in Bear Lake, Barron County, WI during 2014.

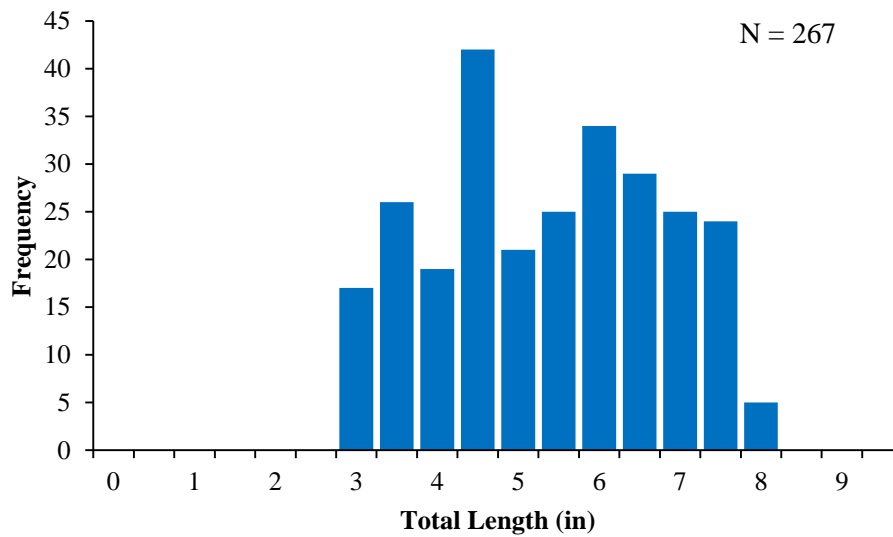


Figure 15. Length frequency histogram for bluegill captured during late spring electrofishing in Bear Lake, Barron County, WI, 2014.

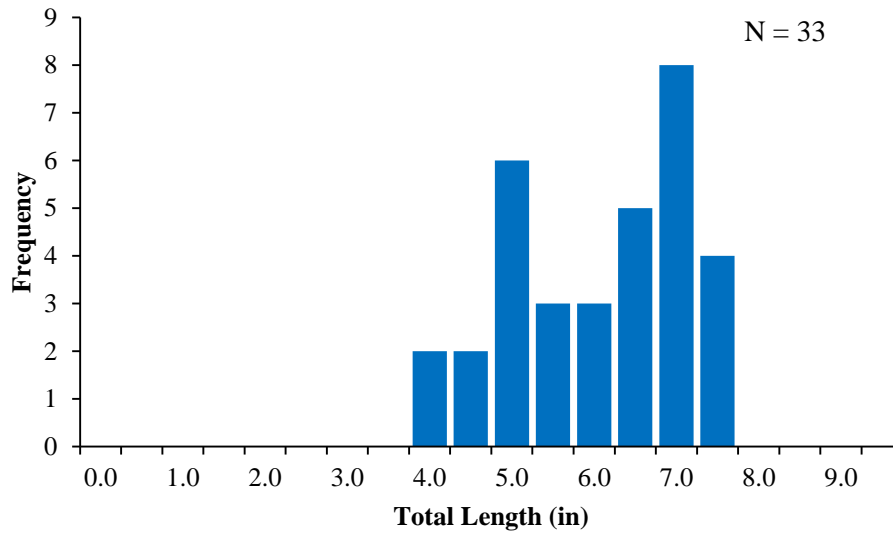


Figure 16. Length frequency histogram for pumpkinseed captured during late spring electrofishing in Bear Lake, Barron County, WI during 2014.

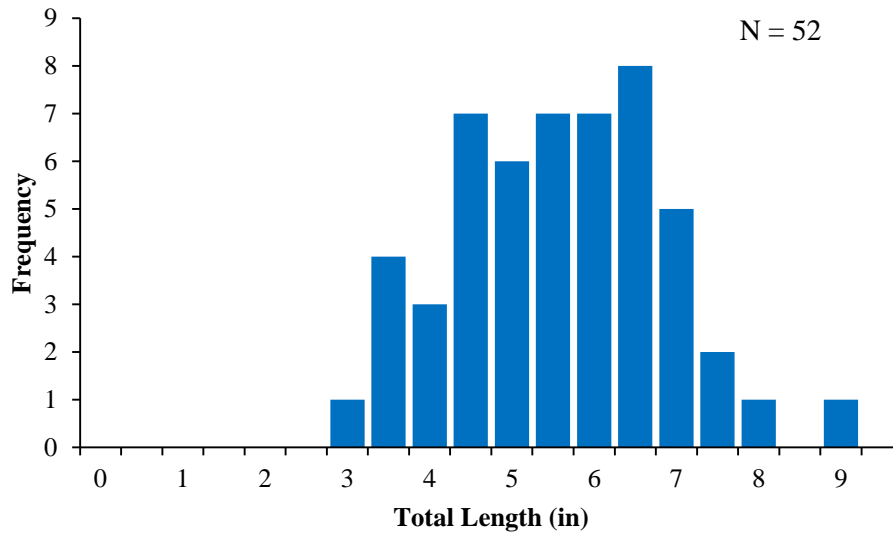


Figure 17. Length frequency histogram for rock bass captured during late spring electrofishing in Bear Lake, Barron County, WI during 2014.

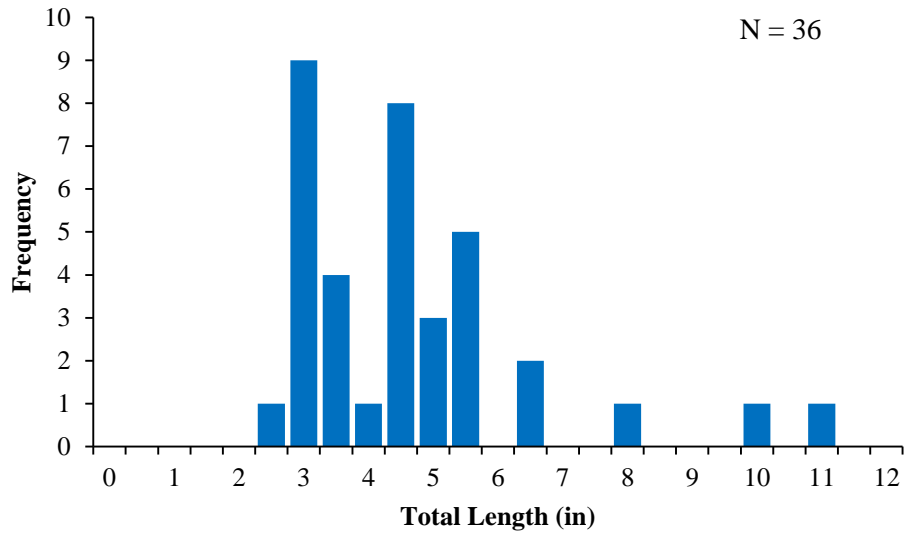


Figure 18. Length frequency histogram for yellow perch captured during late spring electrofishing in Bear Lake, Barron County, WI during 2014.

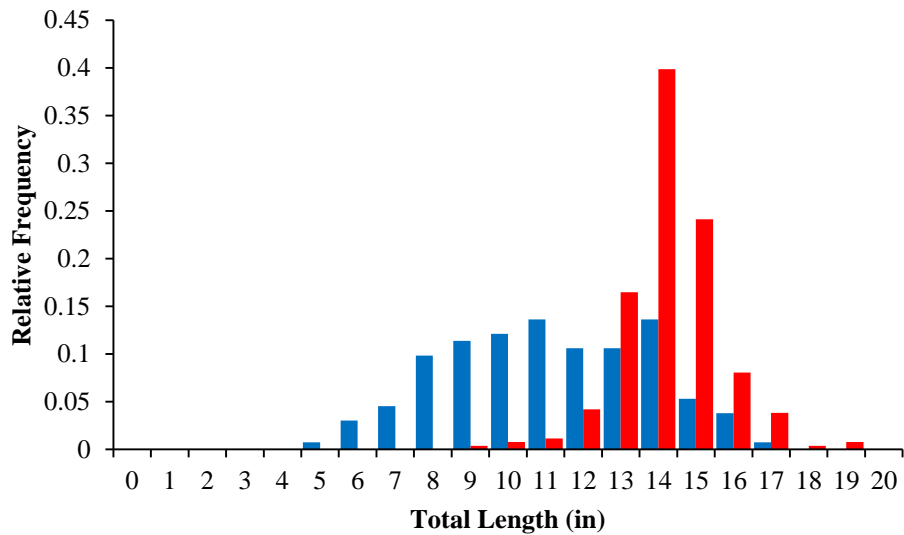


Figure 19. Relative frequency histograms of largemouth bass harvested (red bars) and captured late spring electrofishing (blue bars) and from Bear Lake, Barron County 2014-2015.

Appendix 1. Lengths (in) used in proportional size distribution (PSD) indices for stock, quality, preferred, and memorable-sized largemouth bass, northern pike, and walleye.

Fish Species	Stock	Quality	Preferred	Memorable
Bluegill	3	6	8	—
Largemouth bass	8	12	15	—
Northern pike	14	21	28	34
Walleye	10	15	20	25